Multidisciplinary Design Under Uncertainty for Entry Vehicles, Phase I

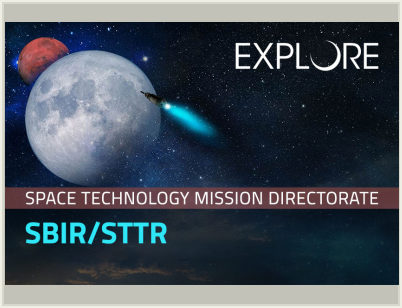
Completed Technology Project (2005 - 2005)

Project Introduction

The physical difficulty of designing entry vehicles originates from the large degree of coupling between the various disciplines involved in the design. Every subsystem design decision has far reaching consequences that must be evaluated in a multidisciplinary fashion in order to assess the impact on the weight and the performance of the entire vehicle. The disciplines which must be accounted and integrated during the design are: trajectory optimization, guidance, navigation, and control (GN&C) technology, aerodynamics and aerothermodynamics, thermal-structural analysis, and thermal protection system (TPS) development. Previous efforts in developing a collaborative or a multidisciplinary optimization process never considered how uncertainty in the atmospheric conditions, in the entry parameters of the vehicle, in the condition of the vehicle during entry, and in the performance of the TPS will influence the design and provide a risk assessment for a mission. The proposed project will fill this void by developing a tool for multidisciplinary optimization under uncertainty (MDO-U) for entry vehicle design. The proposed development will consider how uncertainties influence the modeling results of each discipline, and how uncertainties influence the interaction between disciplines and the optimal solution. Finally, the new MDO-U design tool will compute the safety level for the optimum design.

Anticipated Benefits

Uncertainties due to manufacturing tolerances, material variability, the operating environment, and the state of the operating structure, are encountered in the automotive, the shipbuilding, the heavy construction equipment, and the defense industries. The MDO-U system will allow engineers to account for uncertainties during the design of their products. Thus, there is a great market potential for the outcome of this SBIR. Uncertainties due to manufacturing tolerances, material variability, the operating environment, and the state of the operating structure, are encountered in aircraft structures, launch vehicles, entry vehicles, and propulsion systems. The ability to account for such uncertainties in all these different areas, during the design stage will be valuable. Therefore, the MDO-U system will be useful to all NASA groups interested in designing space vehicles or aircraft.



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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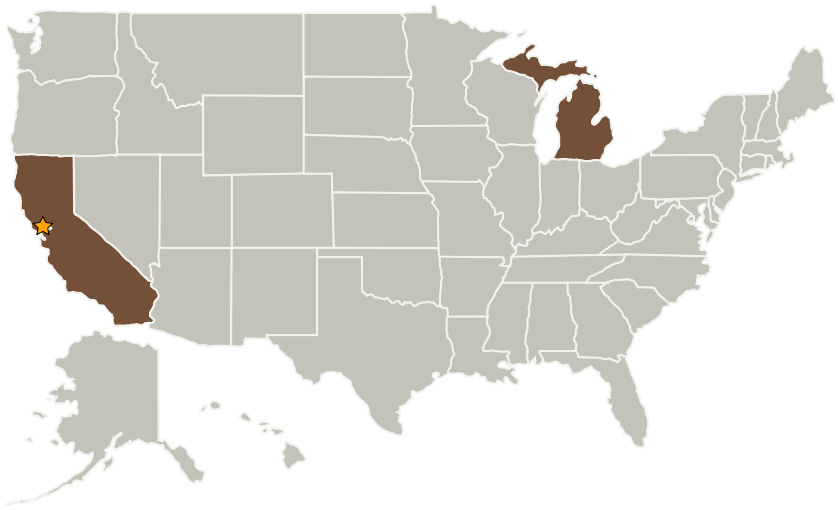
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Michigan Engineering Services, LLC	Supporting Organization	Industry Women-Owned Small Business (WOSB)	Ann Arbor, Michigan

Primary U.S. Work Locations	
California	Michigan

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Project Manager:
Unmeel B Mehta

Principal Investigator:
Nickolas N Vlahopoulos

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL